CLAIMS

1. A method for forming a single-phase c-axis $Pb_5Ge_3O_{11}$ (PGO) ferroelectric film overlying a noble metal electrode, the method comprising:

forming a bottom electrode polycrystalline mixture of a first noble metal and an oxide of the first noble metal; and,

forming a single-phase c-axis PGO ferroelectric thin film overlying the bottom electrode.

2. The method of claim 1 wherein forming a bottom electrode polycrystalline mixture of a first noble metal and an oxide of the first noble metal includes using a noble metal selected from the group including Pt, Ir, and Ru.

3. The method of claim 1 wherein forming a bottom electrode polycrystalline mixture of the first noble metal and first noble metal oxide includes forming a polycrystalline mixture, using a noble metal selected from the group including Pt and Ir, having a preference in the (111) orientation.

4. The method of claim 1 wherein forming a bottom electrode polycrystalline mixture of the first noble metal and first noble metal oxide includes:

forming a first layer including a mixture of the first noble metal and first noble metal oxide; and,

forming a second layer, interposed between the first layer and the ferroelectric thin film, of the first noble metal oxide.

5. The method of claim 1 wherein forming a bottom electrode polycrystalline mixture of the first noble metal and first noble metal oxide includes:

forming a first noble metal first layer; and,

forming a second layer, interposed between the first layer and the ferroelectric thin film, of the first noble metal oxide.

6. The method of claim 1 wherein forming a bottom electrode polycrystalline mixture of the first noble metal and first noble metal oxide includes:

forming a Pt first layer; and,

forming a second layer, interposed between the first layer and the ferroelectric thin film, of fully oxidized Pt_3O_4.

7. The method of claim 1 wherein forming a single-phase c-axis PGO ferroelectric thin film overlying the bottom electrode includes forming a pure c-axis PGO thin film.

8. The method of claim 1 wherein forming a bottom electrode polycrystalline mixture of the first noble metal and first noble metal oxide includes:

reactive sputtering the first noble metal in an atmosphere including Ar and O2; and,

annealing the mixture in an O2 atmosphere.

9. The method of claim 8 wherein reactive sputtering the first noble metal in an atmosphere including Ar and O2 includes, with respect to a base pressure of 7×10^{-7} Torr:

using a Ar partial pressure in the range of 1 to 5 milliTorr (mTorr); and,

using an O2 partial pressure in the range of 1 to 5 mTorr.

10. The method of claim 8 wherein reactive sputtering the first noble metal in an atmosphere including Ar and O2 includes, with respect to a 4 inch diameter target, using a sputtering power in the range of 50 to 500 watts.

11. The method of claim 8 wherein annealing the mixture in an O2 atmosphere includes rapid thermal annealing (RTA) at a temperature in the range of 400 to 800 degrees C, for a duration in the range of 1 to 60 minutes.

12. The method of claim 1 further comprising:

forming a top electrode overlying the PGO ferroelectric thin film.

13. The method of claim 1 wherein forming a bottom electrode polycrystalline mixture of a first noble metal and an oxide of the

first noble metal includes forming a bottom electrode mixture having a sheet resistance of less than 5 ohms/square.

14. A method for forming a single-phase c-axis $Pb_5Ge_3O_{11}$ (PGO) film overlying a Pt metal electrode, the method comprising:

forming a bottom electrode mixture of Pt and Pt_3O_4; and,

forming a single-phase c-axis PGO thin film overlying the bottom electrode.

15. The method of claim 14 wherein forming a bottom electrode mixture of a Pt and Pt_3O_4 includes:

forming a Pt first layer; and,

forming a second layer, interposed between the first layer and the PGO thin film, of fully oxidized Pt_3O_4.

16. The method of claim 14 further comprising:

forming a top electrode overlying the PGO thin film.

17. The method of claim 14 wherein forming a bottom electrode mixture of Pt and Pt_3O_4 includes forming a polycrystalline mixture of Pt and Pt_3O_4.

18. The method of claim 14 wherein forming a bottom electrode mixture of Pt and Pt_3O_4 includes forming a bottom electrode mixture having a sheet resistance of less than 5 ohms/square.

19. A $Pb_5Ge_3O_{11}$ (PGO) ferroelectric capacitor comprising:

a bottom electrode including a polycrystalline mixture of a first noble metal and an oxide of the first noble metal;

a single-phase c-axis PGO ferroelectric thin film overlying the bottom electrode; and,

a top electrode overlying the PGO ferroelectric thin film.

20. The capacitor of claim 19 wherein the bottom electrode includes a noble metal selected from the group including Pt, Ir, and Ru.

21. The capacitor of claim 19 wherein the polycrystalline mixture of the first noble metal and first noble metal oxide is a noble metal selected from the group including Pt and Ir, having a preference in the (111) orientation.

22. The capacitor of claim 19 wherein the bottom electrode polycrystalline mixture of the first noble metal and first noble metal oxide includes:

a first layer including a mixture of the first noble metal and first noble metal oxide; and,

a second layer, interposed between the first layer and the ferroelectric thin film, of the first noble metal oxide.

23. The capacitor of claim 19 wherein the bottom electrode polycrystalline mixture of the first noble metal and first noble metal oxide includes:

a first noble metal first layer; and,

a second layer, interposed between the first layer and the ferroelectric thin film, of the first noble metal oxide.

24. The capacitor of claim 19 wherein the bottom electrode polycrystalline mixture of the first noble metal and first noble metal oxide includes:

a Pt first layer; and,

a second layer, interposed between the first layer and the ferroelectric thin film, of fully oxidized Pt_3O_4.

25. The capacitor of claim 19 wherein the PGO ferroelectric thin film is a pure c-axis PGO film.

26. The capacitor of claim 19 wherein the bottom electrode has a sheet resistance of less than 5 ohms/square.

27. A single-phase c-axis $Pb_5Ge_3O_{11}$ (PGO) film capacitor comprising:

a bottom electrode mixture of Pt and Pt_3O_4;

a single-phase c-axis PGO thin film overlying the bottom electrode; and,

a top electrode overlying the PGO thin film.

28. The capacitor of claim 27 wherein the bottom electrode mixture of Pt and Pt_3O_4 includes:

a Pt first layer; and,

a second layer, interposed between the first layer and the PGO thin film, of fully oxidized Pt_3O_4.

29. The capacitor of claim 27 wherein the bottom electrode mixture of Pt and Pt_3O_4 is a polycrystalline mixture of Pt and Pt_3O_4.

30. The capacitor of claim 27 wherein the PGO ferroelectric thin film is a pure c-axis PGO film.

31. The capacitor of claim 27 wherein the bottom electrode has a sheet resistance of less than 5 ohms/square.